GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT INITIATION

Date: June 18, 1973

Project Title: Extrudable Soullike Composites

Project No.: A-1547

Project Director: W. R. Burrows

Sponsor: Two-O-Two Corporation

Effective: June 11, 1973 . . . . . Estimated to run until: December 31, 1973 . . . . .

Type Agreement: Standard Industrial Research . . . . . Amount: $ 27,440 . . . . .

Remarks: Quarterly Progress Reports, Letter Type
Final Technical Report due by January 31, 1975

CONTACT PERSON: (Technical)
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(Administrative)
Mr. Robert E. Yo
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Cedar Rapids, Iowa 52405

Assigned to: Technology Applications Group . . . . . Division

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FRA-62

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

no action 6 ACS CHL

Date: 3/4/77

Project Title: Extrudable Woodlike Composites

Project No: A-1547

Project Director: Mr. W. H. Burrows

Sponsor: Two-O-Two Corporation

Effective Termination Date: 6/30/75

Clearance of Accounting Charges: _____

Grant/Contract Closeout Actions Remaining:

- _ Final Invoice and ~~Closing Documents~~
- _ Final Fiscal Report
- _ Final Report of Inventions
- _ Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- _ Other _____

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CA—4 (3/76)

A-1547

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 30, 1973

Two-O-Two Corporation
202 F Avenue, N. W.
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

Subject: Monthly Letter Report, No. 1
Project A-1547, "Extrudable Woodlike Composites"

It was our plan at the outset, as indicated in our discussion at the time of Mr. Shore's visit, to work towards a cellular structure for the dual purposes of decreasing density and increasing strength. Compositions involving wood flour accomplish the former purpose; however, the extent to which the latter purpose is accomplished depends largely upon the characteristics of the particular binder used.

We commenced our experimentation with the thought of working with polymeric materials which were susceptible to formation of fine foam structures by use of suitable blowing agents. It would appear likely that during the extrusion process, spherical cells would be converted into tubular ones, oriented parallel to the length of the pencil, provided a longitudinal "bundle" type strength and rigidity. Additional strength could be imparted by incorporating short fibers of cellulose (e.g., cotton linters, rayon fibers, etc.).

Among materials selected for initial experimentation were polystyrene, rigid vinyl and ABS (acrylonitrile-butadiene-polystyrene copolymer). Mr. Jain placed on order suitable samples of these various materials; then, while waiting for their arrival, started his experimentation with expanded polystyrene. This material, available in many forms, melts into a fine cellular structure, into which we were able to blend short staple fibers. We have not extruded this composition, but it is not without promise.

Of far greater promise, however, is an expandable ABS which we have received. We are enclosing literature on Cycolac JXP (the brand we have), whose density unexpanded is 1.3 g/cc, but which expands to densities of 0.3 to 0.6. This puts it right in the cedar wood range. Its many favorable properties (heat distortion temp., tensile and flexural characteristics, etc.) are enhanced by its sharpenability and the ease which it may be colored and given a wood-grain

appearance. Right now, we feel very good about this material. It also appears that we should be able to extrude it without too much modification of the extruder. Mr. Jain is planning to extrude some in 1/4-inch rods, which will enable us to tell more about its potential for pencil making.

Other materials are also on order and will be included in our experimental program. By this time next month, we should have sufficient experimental results to make preliminary decisions as the best direction to take in the matter of composites.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

WHB/edh

Enclosures

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

October 4, 1973

Two-O-Two Corporation
202 F. Avenue, N. W.
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw, Vice President

Gentlemen:

Subject: Monthly Letter Report No. 2, Project A-1547,
"Extrudable Woodlike Composites"

In last month's report, we wrote of our intention to give primary consideration to ABS polymers, with especial attention to Cycolac JXP. Literature which was forwarded with our report showed this material to have many of the properties towards which we were working. Accordingly, we received samples of this material and were able during the month to make some crude extrusions, samples of which will be forwarded to you.

Our reaction to this material in the laboratory is that it is a difficult material to work with and might require some specialized equipment for proper processing. In our work, we have simply used equipment already on hand and made such adjustments as could be made to accommodate to the characteristics of the raw resin.

The manufacturer of this resin informed us of the existence of a patent on its application to pencil manufacture, namely U.S. Patent No. 3,704,071, copy of which is attached. We have given the claims of this patent considerable study and feel that it would be quite difficult to produce an acceptable product with ABS without infringing it. Were you to decide that ABS was the best material for your product, it would probably be necessary for you to obtain a license from Bayer Aktiengesellschaft, owner of the patent. This is possibly the course taken by Empire (see enclosed clipping).

Your cost analysis of the use of ABS, however, indicates that such action would not provide you with a product that you could profitably manufacture. We agree. Consequently, we have turned our attention to other materials in the interest of maintaining the desirable properties towards which we have been working, but at lower cost.

The cellular structure is a must, if we are to realize a sufficiently low density and retain good sharpenability; consequently, foam formation is a requirement of the process. Vinyls offer this possibility, but have comparatively low softening points. Polystyrene is preferable; however, at present it is in such short supply that we are having difficulty even getting samples. Acrylics seem to be excluded by the above mentioned patent, but the claims on polystyrene seem to be less restrictive. We will probably end up with a blend of polymers, copolymers, fillers, pigments, additives, etc. to achieve the required physical properties and avoid infringing prior art. Towards this end, we are getting materials on order as rapidly as we can see their applicability to our formulations.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

WHB:ct

Enclosure

cc: Mr. Sid Shore
Mr. Sam Linton

A-1547

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

November 12, 1973

Two-O-Two Corporation
202 F. Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw, Vice President

Subject: Monthly Letter Report No. 3, Project A-1547
"Extrudable Woodlike Composites"

Gentlemen:

Experimental work during the month of October was given to further extrusion studies using ABS and high impact polystyrene, together with foaming agents. Significant data from the ABS studies, together with previous PVC studies are given in Tables I and II.

As yet, satisfactory results have not been obtained with polystyrene, due to difficulties in blending foaming agents into the polystyrene stock. This difficulty is being attacked through improved blending. As yet, the Baker-Perkins had not been deemed necessary; however, it is now being reconditioned for use in this operation. Also, it has not been possible to make a selection of most suitable foaming agent, because of the blending difficulty.

As mentioned in a previous report, we are also interested in waste materials. Some preliminary results have been obtained with waste from a tufted carpet mill, and results look interesting. We are not in a position to comment quantitatively on the resulting material at present, but intend to explore this line further.

In view of the relatively strong patent position taken by Bayer Aktiengesellschaft with respect not only to ABS but also to polystyrene, acrylonitrile and other polymeric materials, it seemed wise at this point to make a thorough study of the patent picture relative to plastic sheathed pencils. Thus far we have reviewed some 24 patents through a process of searching citations. We expect to complete this study this week, and will prepare a summary at that time.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

ct

TABLE I

EXTRUSION OF PVC*

Sample No.	Temperature °C Zone: 1	2	3	Die	RPM	Torque/5 (g-meter)	Withdraw Rate gr/30 sec.
1**	190	195	205	210	30	850	28/2 = 14
2	185	190	200	205	30	940	29/2 = 14.5
3	180	185	195	200	30	>980	14
4	175	180	190	195	30	>980	15.5
5***	170	175	185	190	20	605	12
6	180	180	180	180	20	950	10
7	175	175	175	175	20	>980	10.5

*Sample from B. F. Goodrich Co., foaming agent incorporated by manufacturer.

**Samples 1-4, rpm of bottom roller while drawing ≈ 10.

***Samples 5-7, rpm of bottom roller while drawing ≈ 5 1/4.

TABLE II

EXTRUSION OF ABS*

Sample No.	Temperatures °C Zone: 1	2	3	Die	RPM	Pressure psi	(Torque/5) gm/meter
1**	188	187	186	179	44-45	~1000	200-300
2***	158	187	186	179	24	~1300	350-375
3	148	187	186	179	24	~ 700	325-350
4	148	187	186	179	24	~1300	425-450 →500
5	148	187	186	179	24	~1300	450-475
6	148	187	186	179	24	~1300	~500
7	148	187	186	179	50	~1500	~500
8	148	187	186	160	20	~1500	~450
9	148	187	186	164	20	~1500	~500-550
10	148	187	186	162	20	1800	~500
11	148	187	186	162	20	2000	600
12	148	187	186	162	20	2400	650
13	148	187	186	162	20	2500	550
14	148	187	186	162	20	~2500	~550

*Marbor Div.

**Sample tended to bridge.

***Sample extruded under tension

****NOTE: Draw rate, i.e. output ~10 g/minute.

ENGINEERING EXPERIMENT STATION GEORGIA INSTITUTE OF TECHNOLOGY
225 North Avenue, Northwest · Atlanta, Georgia 30332

December 11, 1973

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

Subject: Monthly Letter Report Number 4, Project A-1547
"EXTRUDABLE WOOD-LIKE COMPOSITES"

Gentlemen:

Laboratory studies have continued to be hampered by the shortage of petrochemical resins. We are making renewed efforts to obtain experimental samples of suitable resins, and have conducted some experiments with such resins as are available. Results have been encouraging as far as incorporation of foaming agents is concerned, since a fair degree of foaming has been achieved even with resins not well adapted to the technique. As soon as samples of resins in the correct melting (and molecular weight) range can be obtained, we expect to be able to demonstrate a satisfactory extruded "pencil" with the properties being sought.

We have obtained additional cost data from Sam Linton and are preparing a cost analysis of the extruded plastic pencil in comparison with conventional wood pencils. We expect to include, also, plastic pencils of other design and construction.

The patent studies reported last month have been continued to determine whether other patents, in addition to those mentioned last month, might be pertinent to the development of a plastic pencil sheath. Thus far, no additional ones have been found, except those which apply to the general art of forming foamed plastic bodies.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

WHH:mar

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

January 16, 1974

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

Subject: Monthly Letter Report No. 5, Project A-1547
"Extrudable Wood-like Composites"

Gentlemen:

During the month of December we had the pleasure of a visit with Mr. Sidney X. Shore, and the opportunity to confer with him on the present status and future plans of the project. At that time, we reviewed for him such matters as the status of project developments relative to the present state of the art, as covered by domestic and foreign patents, and the cost picture of plastic pencils manufactured by both extrusion and injection methods, relative to the cost of conventional wood pencils. He reviewed for us the criteria to be considered in developing plastic composites intended for pencil sheath manufacture.

Summaries of these reviews are being prepared and will be provided for the files of all policy personnel of the project.

Laboratory work has been limited, due to the intrusion of the Christmas recess, which was extended an additional two days because of the energy crunch. However, the enclosed two samples may be of some interest, not as meeting the criteria, but as an indication of what may be done with scrap materials. Both are prepared from polypropylene reinforced with macerated carpet waste. That which was extruded in the pencil shape was roughly milled, and incompletely blended with the resin. The waste contained a high proportion of dark materials, and apparently some carbonization occurred at the surface. Nevertheless, with a better choice of filler material, better blending, and improved control in the extrusion process, the qualities of the final product would be considerably improved. The flat sample incorporates a better quality of reinforcing fiber (also carpet waste) and better milling; obviously, it was injection molded.

Additional samples of polystyrene have been obtained, and further laboratory work on these is planned for the present week. Efforts are

continuing to obtain additional samples of materials compounded more to the purpose of the present need.

Respectfully submitted,

W. H. Burrows
Project Director

ct

Enclosure

A-1547

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

February 12, 1974

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

Subject: Monthly Letter Report No. 6, Project A-1547
"Extrudable Wood-like Compositions"

Gentlemen:

Following several conversations with Dow Chemical Company scientists and sales personnel by Dr. Muzzy and Mr. Burrows, we finally succeeded in securing experimental ten-pound quantities of foamable polystyrene. The materials are "Styron" 420-27, Natural No. 7, and "Styron" 430U NBR 7.

The 430 has been compounded with blowing agent and extruded, with the results seen in the accompanying samples. Sample A shows the rough surface produced when the extrusion rate is too high. Sample B demonstrates that this material can be extruded satisfactorily and that the product will have good sharpenability, satisfactory density and a color which can easily be modified to resemble that of natural cedar. The product does not have satisfactory flexural properties. It is also flammable, producing tags of black soot.

Modification of these characteristics might be possible with some blending and annealing. We are now attempting to secure samples of other resins, such as styrene-acrylonitrile copolymer, which might be used separately or blended with the polystyrene. These modifications should improve the flexural properties. The flammability can be controlled by introducing flame retardant materials.

Samples of cotton and various synthetic fibers, some in quite short staple lengths, have been secured. Unfortunately, reinforcement with fibers can be used to only a limited degree in extrusion molding, as the fibers tend to accumulate at the die and produce erratic results. Should development of suitable materials indicate a preference for injection, over extrusion, molding, compounding with fibers would be a much simpler procedure.

During the current month, we are engaged in the following activities: (1) More closely defining the specific chemical and physical properties of the cedar wood used in conventional pencils, in order to more closely define

the required properties of plastic composites, (2) Intensifying our search for candidate materials in the polymer field, and (3) Continuing compounding and extrusion studies.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

ct

cc: Mr. Sidney X. Shore
Mr. Sam Linton
Dr. John Muzzy

A-1547

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

March 19, 1974

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

Subject: Monthly Letter Report No. 7, Project A-1547
"Extrudable Wood-like Compositions"

Gentlemen:

Following announcement of the commercialization of a plastic pencil by Empire, we have delayed preparing this report until we had the opportunity of examining samples of Empire's product. Mr. Sam Linton has kindly provided us with two of these pencils. Our initial reactions are outlined in our letter of March 11 to Mr. Linton, as follows:

> The "cedar" coloring of the sheath is very good. I am surprised to learn, however, that the pencils are painted after cutting to length; the publicity I recently read indicated that finish color was applied during the extrusion process. I can see that finishing, stamping and ferruling, together with cost of materials, might well present manufacturing costs well in excess of those for which we are shooting.
>
> Flammability would appear to be a strong factor against acceptance of this pencil, particularly in the school trade. FTC is moving more and more strongly towards control of flammability in commercial products, as well as in general safety of children-associated items, such as toys. Both flammability of the resin and irritating effects of the combustion products would be factors worth avoiding, if at all possible.

Incorporation of flame inhibitors would undoubtedly increase the density of the plastic and probably, depending upon the particular inhibitor used, introduce toxicity hazards. For these reasons, as well as for the advantages offered by the equipment and techniques of injection molding, it appears that

the time has come to seriously consider injection molding as a preferred alternative to extrusion for this application.

We are at present examining injection molding of several filled resin systems, utilizing both fibrous and non-fibrous fillers. It is our belief that the particular resins, plus the materials used as fillers, will provide the necessary mechanical properties, while providing non-toxic flame resistance. We anticipate that the filled resin density will exceed that of wood, although the density might be reduced somewhat by foaming.

Modification of the present ferrule design, coupled with design of the mold, might well provide the opportunity for molding the complete pencil sheath around the lead with ferrule attached. The product would need only painting and stamping as finishing operations.

In order to pursue these ideas as rapidly as possible, we are revising the schedule of the project. Dr. Muzzy's commitment to the project has been increased from 10 percent to 30 percent for the remainder of the school year. His technical assistance will be increased accordingly. In this way, we feel that we shall have very significant results to report by the end of June 1974.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

ng
cc: Mr. Sidney X. Shore
Mr. Sam Linton
Dr. John Muzzy

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

April 16, 1974

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

Subject: Monthly Report No. 8, Project A-1547
"Extrudable Wood-like Compositions"

Gentlemen:

Our Monthly Report No. 7, March 19, 1974, described the course of action which we considered would be most productive. Injection molding was preferred over extrusion, and foamed, fiber-filled resins, or resins reinforced with other fillers were preferred over the ABS used in other pencils.

Accordingly, we have accumulated samples of various filler and reinforcing materials, including natural and synthetic fibers, talc, calcium carbonate, zinc oxide and titanium oxide. Compositions have been prepared in which these materials are blended with high density polypropylene and high density polyethylene. These compositions have been cast into test strips and tested for sharpenability and flexural modulus.

In addition, flexural moduli have been determined on a number of foamed, glass-filled plastics, including nylon, polystyrene, acrylic and polypropylene, as well as on wood (cedar flats), wood pencil with lead, and plastic pencil with lead. The accumulation of data from these runs are serving as a guide to the further selection of materials.

The raw materials situation, which was critical during the latter part of 1973, has now relaxed to a degree. Consequently, we have been able to secure promises of 25-pound experimental quantities of resins from several manufacturers. Included are low impact, or general purpose, polystyrene, low acetate polyvinyl acetate-chloride copolymer, and possibly polypropylene.

A cylindrical mold has been rigged in which it will be possible to mold rods of the various filled and foamed resins. The same mold, with a slight modification, will also serve for molding sheaths around standard

pencil leads of the ceramic type. Samples of these molded products will be forwarded to you later this month.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

ng

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

May 15, 1974

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

Subject: MONTHLY REPORT NUMBER 9, PROJECT A-1547
"EXTRUDABLE WOOD-LIKE COMPOSITIONS"

Gentlemen:

Work for the past period has centered upon compositions of various fillers with resins, principally high density polyethylene. While these compositions have been formed into rods and pencils by injection molding, they would lend themselves equally well to extrusion molding.

Fillers used have included talc, titanium dioxide, zinc oxide and calcium carbonate (precipitated chalk). These have been compounded with high density polyethylene in a 50:50 mix, extruded as rods, and tested in the flexure testing instrument. Table 1 shows the flexural displacement for each of the compositions under increasing loads. The table includes a value for ABS with 5% blowing agent, molded into a rod of the same diameter (9/32 inch). Also included are values for wood pencil, although these values, representing a somewhat larger diameter (5/16 inch) and containing lead, are not fully comparable. It may be noted from Table 1 that the talc formulation represents the best value and is an improvement over the slightly foamed ABS. It does not greatly exceed that of the wood pencil.

Our optimism concerning the availability of experimental resins has not been fully substantiated. Apparently, the shortage will be with us for some time yet. The effects are represented not only in inability of resin manufacturers to supply samples (Shell says that it is selling every grain it can make), but in removal from product lines of all custom or specialty blends, such as Phillips' talc-filled polypropylene. Dow, in addition, has been reluctant to supply polystyrene samples for this

Contd./...

project, since they worked with Empire in designing the plastic pencil now appearing under the name, *"The Epcon Pencil,"* a polystyrene composite. Dr. Muzzy is attending a national meeting of the Society of Plastic Engineers in Los Angeles this week and hopes to make contact with some suppliers there from whom samples will be available.

We are sending along some pencils of the talc composition molded by injection around ceramic leads. We have, as yet, not introduced any colors into the sheaths, but that should present no great difficulty. One drawback is the somewhat greater flexibility than wood, with the consequence, that bending is more likely to cause breaking of the ceramic lead. This would be overcome by going to a plastic lead composition of similar resin structure. We expect to experiment with such compositions during the ensuing month.

Yours very truly,

[redacted]

W. H. Burrows
Project Director

WHH:mar

Attachment

TABLE 1

FLEXURAL VALUES FOR HIGH DENSITY

POLYETHYLENE COMPOSITIONS

(Filler Level 50%)

Filler (at 50% level)	Load:	1	2	3
		Flexural Displacement (mm)		
Talc		2.5	5.5	9.25
Titanium dioxide		5.42	11.8	18.3
Zinc oxide		5.88	14.38	23.0
Calcium carbonate		5.5	11.75	17.75
ABS + 5% blowing agent		5.0	10.5	15.5
Wood pencil, round		1.25	2.50	3.50

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

June 14, 1974

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

SUBJECT: MONTHLY REPORT NUMBER 10, PROJECT A-1547
"Extrudable Wood-like Compositions"

Gentlemen:

Composition studies have progressed very satisfactorily during this period. Supplies of experimental resins have been received from Monsanto (Lustrex), Exxon (Dexon 1002 and 1003), Dupont (Alathon) and Phillips (Marlex). In addition, studies have included resins already on hand. Unfortunately, studies with some of these resins have been limited by the particle size (pellet, rather than powder), however unfilled rods have been formed with all resins.

The list of fillers used was given in Report No. 9. However, best results have been obtained with combinations of resin, talc and wood flour. Specimens are included, prepared with Marlex in ratios of 40:20:20, 50:20:20 and 60:20:20 parts by weight of resin, talc and wood flour, respectively. It may be noted that these specimens show a "shell" or "skin" effect, being more porous in the vicinity of the lead, with density increasing radially. This has the desirable effect of providing the rigidity associated with cylindrical construction.

Attempts are being made to obtain some of the resins in powdered, rather than pellet form. Of particular interest are the Exxon resins, which are acrylic modified polyolefins. These should provide improved bonding to both fillers and leads. We are also seeking means for reducing the pellets to powder form on a laboratory scale.

Preparations are being made to determine flexural moduli somewhat more accurately than in the past. An Instron tester is being made available to the project for this purpose. Density measurements of the formed rods, with and without the various fillers, are also underway.

As mentioned previously, the compositions and techniques being developed will be equally applicable to either extrusion or injection molding. The submitted specimens have been injection molded.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

ng
enclosure

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

July 16, 1974

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

SUBJECT: MONTHLY REPORT NUMBER 11, PROJECT A-1547
"Extrudable Wood-like Compositions"

Gentlemen:

Following up the findings of last month on compositions, attention has been directed this month primarily to the initiation of experiments in extrusion of a sheath around a ceramic lead core. The formulations used continue the previous variations on the 60:20:20 ratio of resin: wood flour:talc. Additional samples of wood flour have been obtained and are being evaluated prior to placing orders for larger quantities. Included are pine, fir and maple.

An experimental extruder head has been constructed of Swagelok fittings. The head makes provision for introduction of the lead through a small diameter brass tube which is inserted in one leg of a tee and held in place by a Swagelok nut. The plastic matrix is forced in through the stem of the tee and out of the arm opposite to that from which the lead enters. As the matrix passes the open end of the brass tube, it grabs the lead which is being pushed through and carries it on out, surrounded with sheath material.

At present, experiments are underway to tie down all of the operational parameters: position of brass tube opening in the head, head temperature, extruder temperature, pressure, rate of extrusion, etc. At present, the extruded pencils do not have the smooth appearance of the injection molded ones, and adhesive bond between lead and sheath is poor; however, it is anticipated that these defects will be modified by more precise control of operational parameters.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

ct

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

May 1, 1975

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

SUBJECT: QUARTERLY REPORT NUMBER A, PROJECT A-1547
"Extrudable Wood-like Compositions"

Gentlemen:

Our progress letter of September 5, 1974, was accompanied by a copy of a cost analysis on plastic pencils prepared by Dr. John Muzzy.

At the time of that letter, we were in the process of discussions with Johnson Plastics Machinery Co., of Chippewa Falls, Wisconsin, concerning their conducting limited production runs, utilizing formulations developed in our laboratory, an experimental lead-injecting die, raw materials supplied by us, and their extrusion equipment. Subsequent to that time, arrangements were completed for the runs, then were postponed to several successive dates because of the interference of unforeseen circumstances. When runs were finally made, they were made by Johnson personnel alone. Results were very discouraging. As a consequence, it was decided that a meeting would be held at the Engineering Experiment Station, Georgia Tech, on January 30, 1975, to assess causes for the failures which had been experienced and to plot a course most likely to lead to early success.

Mr. Shore agreed to undertake the task of finding a plastics machinery fabricator with experimental facilities in a suitable location for cooperation with the project. By way of providing Mr. Shore with information to expedite his search, we provided you and Mr. Shore with the following materials in our letter of February 10.

(1) Criteria for selecting process developers.

(2) List of companies contacted last year when we first started looking for process developers. Included was a sample of the letter which went out to each of the companies on this list. Also included was a summary of the responses received from these companies. The list was compiled from the classified directory of the 1973-74 Modern Plastics Encyclopedia.

(3) A selection of companies which sell take-off equipment, extruders and foam extrusion equipment, from MPE 1974-75 edition. Attached were the Xeroxed listings from MPE. This listing represents an updating of that used last year.

(4) Comments on processors made by Mr. K. W. Andruszka, August 4, 1974. These comments are probably still valid.

In addition, Dr. Muzzy provided information on resin suppliers, as well as his own comments on the companies listed in Item 2.

We have been in recent communication with Mr. Shore, who has located a company which is willing to undertake the type runs required to accumulate production data. In response to his request, we are forwarding shortly a list of the formulations which appeared to have the most promise for extrusion of plastic sheaths for ceramic leads, together with a compilation of the specific characteristics of pieces made from those formulations.

We are also preparing a review of the patent position for these formulations, as well as for foaming PVC and styrene compositions, such as those used by Empire and Eagle in their all-plastic pencils.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

ct

cc: Mr. Sidney X. Shore
Mr. Sam Linton
Dr. John Muzzy

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 29, 1975

Two-O-Two Corporation
202 F Avenue
Cedar Rapids, Iowa 52405

Attention: Mr. Robert E. Yaw
Vice President

Subject: Quarterly Report Number X, Project A-1547
"Extrudable Wood-Like Compositions"

Gentlemen:

At the request of Mr. Sidney X. Shore, we have conducted a survey of the patent literature pertinent to developments made during the course of our experiments on the subject project. This survey covered the period 1966 to the present and was directed toward U. S. Class 401-96. It covered only U. S. patents, to supplement our previous search, reported to you on January 18, 1974.

Five patents were discovered in this classification, as follows:

U. S. Patent No.	Date	Inventor	Title
3,516,753	6/23/70	C. A. Dickey	Writing instrument and process of making the same
3,520,627	7/14/70	Y. Suzuki	Writing instrument
3,551,064	12/29/70	B. I. Bartner	Unitary composite article and method of manufacturing the same
3,586,452	6/22/71	R. A. Mason	Cosmetic container
3,846,029	11/5/74	E. Benn, et al	Dispenser assembly for wax substances

Of these, only the first three have any significance relative to the project. Our comments relative to these are as follows.

1. Dickey, USP 3,516,753

A water-in-resin emulsion, having a polyester matrix with curing agent, is poured into a mold. A graphite lead is inserted coaxially. After setting,

the pencil thus formed is heat cured. The inventor claims control of density and mechanical parameters through variation of the water content; he also claims a similarity to wood in texture, "feel" and machinability. A disadvantage is the comparatively long period required for curing.

2. Suzuki, USP 3,520,627

A heat-shrinkable plastic tube is used as an outer cover of a pencil to provide finish and increased strength. The film may additionally be bonded to the pencil by an adhesive.

3. Bartner, USP 3,551,064

A foamed plastic tube with non-foamed outer "lining" forms the "body", or sheath, of the pencil, and a ceramic lead is inserted while the body and/or lead is heated. Heat provides the needed distortion of the body to permit insertion, and at the same time assists in forming an adhesive bond between lead and body. The cellular structure of the foamed plastic provides ease of sharpening as well as lower density, so that the body approaches the texture and machinability of wood.

It is our opinion that none of these patents would be cited as interference in an application for patent on the process developed in our laboratories. In essence, the features of our process which we feel would provide patent protection are the following:

There are two basic areas which appear to have patent potential: the pencil sheath recipe and the process for extruding this recipe with conventional lead.

The preferred recipe consists of 60% by weight polystyrene (e.g., Cosden 525) and 40% fillers. The fillers can be comprised of talc and wood flour in combination or separately. The wood flour provides a lower density product but is generally more difficult to process. A low molecular weight (high melt index) polystyrene is preferred in order to minimize the die temperature. A low die temperature minimizes blooming of plasticizers from the lead. To my knowledge no patents for pencil sheathing compounds are based on polystyrene. ABS and PVC have been most frequently claimed in patents.

The extrusion of plastic sheat over conventional lead apparently has not been patented. Therefore the extrusion techniques employed on this project should be novel. An important feature of our extrusion process is the low die temperature of 175°C. Also, the extrusion was facilitated by using pre-coated leads (essentially an epoxy varnish) which improved the wetting of the hot plastic with the lead and further minimized blooming of the plasticizers in the lead.

While these features appear to be novel, further refinement of the recipe and the process is needed before applying for a patent.

Please feel free to contact us regarding any of the above material.

Respectfully submitted,

[redacted]

W. H. Burrows
Principal Research Scientist

WHB/db